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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/500,654	07/02/2004	Michel Puech	Q82315	2879

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SUGHRUE MION, PLLC
2100 PENNSYLVANIA AVENUE, N.W.
SUITE 800
WASHINGTON, DC 20037

EXAMINER

DAHIMENE, MAHMOUD

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 12/28/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/500,654

Applicant(s)

PUECH ET AL.

Examiner

Mahmoud Dahimène

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 July 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-16 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-16 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>7/02/2004</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Objections

1. Claim 8 is objected to because of the following informality: the term "attack" does not technically fit within the context of rest of the claim. Appropriate correction is required.

For the purpose of the present examination, the examiner assumes it is a typographical error and substitutes the term "attack" with "attract".

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1-5, 8, 15 are rejected under 35 U.S.C. 102(b) as being anticipated by Bhardwaj et al. (WO 00/05749).

Bhardwaj discloses a method and apparatus for anisotropic etching any substrate/layer including Si, with a defined mask pattern (page 27, line 18), cyclically (page 27, line 3) performing the steps of: (a) etching the material or film, (b) depositing or forming a passivation layer on the surface of the etched feature, (c) selectively removing the passivation layer from the etched feature (bottom) in order that the etching

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proceeds in direction substantially perpendicular to the film or material surface (page 27, lines 5-10). All 3 steps can be performed with a plasma (page 27, line 11, line 16).

As to claim 2, Bhardwaj cites the 3 steps are cyclically performed (page 27, line 3)

As to claim 3, Bhardwaj cites each step (a) to (c) is performed as a separate step (page 12, line 19) without overlap.

As to claim 4, Bhardwaj cites NF₃ as a silicon etching gas (page 6, line 27) and (page 15, line 21).

As to claim 5, Bhardwaj cites C_xF_y, C_xH_y and C_xH_yF_z are used for passivation where x, y and Z could be any suitable values (page 10, line 10).

As to claim 8, Bhardwaj cites the support (of the substrate) is in the form of a first electrode (page 30, line 21), also, an electrical bias is applied to the substrate support to accelerate ions onto the substrate (page 30, line 31).

As to claim 15, the reference of Bhardwaj discloses an apparatus (page 30, line 10) for performing the process steps (a), (b) and (c) described above, the apparatus comprises: a chamber, having chemical inlet (gases inlet) and outlet (vacuum), in which is positioned a support for receiving a substrate, means for etching with one or more appropriate chemicals (page 30, lines 10-20). The apparatus is capable of performing a cyclic etch (page 16, line 10) which implies programmed duration and programmed flow rates capability must be included. Means for generating a plasma in the chamber (page 30, line 24). Means for biasing the substrate (page 30, line 27).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claim 6, 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bhardwaj et al. (WO 00/05749) in view of Rattner et al. (US 6,846,746)

The reference of Bhardwaj, described above, is silent about a cleaning gas containing oxygen.

Rattner discloses a method of smoothing a trench sidewall after a deep trench silicon etch process where an oxygen gas plasma is used to remove polymer residue from the trench sidewalls (column 10, line 10).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Bhardwaj to include oxygen as gas for plasma cleaning because the reference of Rattner teaches oxygen gas plasma is effective for removing polymer. One of ordinary skill in the art would have been motivated to use an oxygen plasma because oxygen gas is readily available in most semiconductor manufacturing facilities.

6. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bhardwaj et al. (WO 00/05749) in view of Mori et al. US 6,136,214).

Bhardwaj discloses an ion energy greater than 10 eV is used for removal of the passivation layer (page 29, line 15), and is preferably between 10 and 100 eV (page 11, line 12) however, Bhardwaj fails to disclose 20 eV as the limit to lower ion energy. The reference of Bhardwaj also fails to disclose the step of increasing the bias voltage progressively from one depassivation step to another.

Mori discloses a plasma processing method and cites "there is an applied voltage between 0 V and -50 V that permits sputtering of only the carbon-based deposits. By applying this voltage during the sample processing, not only can the reactive species control be performed, but also deposits on the plasma boundary surface can be removed, which in turn shortens or eliminates the oxygen cleaning, improving the total throughput. In this case, the sample processing and the voltage application to the radical control material may be performed at different timings. The plasma boundary surface can also be cleaned in a similar manner by introducing a cleaning gas (oxygen, argon, etc.)" (column 13, lines 4-15).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a depassivation step with a bias between 10 to at least 100 V or possibly higher voltage because both cited references suggest a relatively low bias for the step of depassivation. One of ordinary skill in the art would have been motivated to use the teachings of both references and determine a proper bias from routine experimentation using the above cited references disclosures as a starting point. Also, one of ordinary skill in the art would have find it obvious to increase progressively the bias voltage as the etched cavity becomes deeper in order to allow

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ions to reach the bottom of the cavity as the cavity depth progresses with each process cycle.

7. Claims 11-14 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Bhardwaj et al. (WO 00/05749).

Applicants claim a pressure range, for the depassivating step of 0.5 Pa to 10 Pa which translates to approximately 4 mTorr to 75 mTorr, and preferably 15 to 37 mTorr.

Bhardwaj cites a pressure range preferably less than 100 mT (page 12, line 16). Applicants claimed pressure ranges are included within Bhardwaj disclosed range, or in the alternative, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use a pressure lower than 100 mTorr because Bhardwaj teaches that pressure range for the depassivation step. One of ordinary skill in the art would have found it obvious to determine the proper pressure within the recommended range of Bhardwaj through routine experimentation.

As to claim 12, it would have been obvious to one of ordinary skill in the art at the time the invention was made to determine the process duration by routine experimentation trying different process times, observing the related results, and selecting the proper process time.

As to claim 13, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to expect more passivation as the passivation step duration is increased, it would also be obvious to expect a longer depassivation step to remove the passivation. One of ordinary skill in the art would have been motivated to

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adjust the duration of the depassivation step as a function of the duration of the passivation step because the depassivation step is supposed to remove material deposited by the passivation step.

As to claim 14, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect that cleaning a polymer near the bottom of a cavity will become harder as the cavity depth increases, and therefore more cleaning time is required.

8. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bhardwaj et al. (WO 00/05749) in view of Ohara et al. (US 6,277,756).

The reference of Bhardwaj fails to disclose a silicon based component, however, Ohara discloses a method for manufacturing a semiconductor device wherein a deep trench with an aspect ratio of 33.4 is etched in silicon (column 5, line 47). The method of Ohara involves repeated steps of etch and deposition.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the modified method of Bhardwaj, discussed above, continuing the 3-step cycling until a trench having an aspect ratio greater than 30 is reached because the method of Bhardwaj is specifically intended to etch deep features. One of ordinary skill in the art would have been motivated to etch a high aspect ratio trench with the modified method of Bhardwaj because the method allows a good profile control.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahmoud Dahimene whose telephone number is (571) 272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Mahmoud Dahimene
MD

LAN VINH
PRIMARY EXAMINER

